

## Investigation of the Environment Effects of Granite Rock Quarry (A Case Study Of Ebenezer Quarry, Akure, Nigeria)

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**Abstract:** This project evaluates the effects of quarrying of granite rock in Ebenezer quarry on the environment. The objectives of the study were achieved through samples collected from the study area. Soil samples were collected at intervals of 0 to 15 cm and 15 to 30 cm for laboratory determination of physicochemical properties. The air quality analysis was also carried out using air particle counter and the noise and vibration generated by the blasting operation in the study area were estimated by adopting mathematical models. The results of the soil samples analysis shown that the average soil pH, for 0-15 cm is 4.86 and for 15-30 cm is 4.87, total organic matter for 0-15 cm is 2.99 and for 15-30 cm is 2.56, total organic carbon 0-15 cm is 1.70 and for 15-30 cm is 1.45 for Nitrogen content between 0-15 cm is 0.15 and between 15-30 cm is 0.12 and total Phosphorous for 0-15 cm is 7.36 and 15-30 cm is 7.06 respectively. The average results of the noise and the vibration level are also given as 0.132 kPa and 51.66 mm/s respectively. The obtained results were correlated using Microsoft Excel Software. The results of the correlation show that the pH of the soil in the study area increase with the increase in the depth this depicts that the land is acidic as a result of the quarry activities in the area. The calcium concentration in the soil has increased and there is also a high concentration of chromium and Cobalt in the soil.

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### I. Introduction

Mining may well have been the second of man earliest endeavours granted that agriculture was the first. The two certainly rank together as the primary or basic industries of human civilization. Another way of expressing the fundamental importance of mining in both ancient and modern culture is to recall that nature provides only limited sources or ways to generate new wealth [1]. Since existence, mining has been integral and essential to man's existence. Mining is, therefore, the extraction of all naturally occurring mineral substances—solid, liquids and gas from the earth for the utilitarian purposes. The total environment in which mineral producing activities take place is the result of the physical, regional and circumstantial conditions that surround and influence the extraction of mineral. The general environment results from and it's structural about the unit operations involved in mining, namely fragmentation, loading, haulage, and support and has four components; physical process, regulatory and social. The physical environment is a function of the geological, hydrological, geographical and ecological nature of the physical space in which the mineral body occurs [2].

It is necessary to define the environment when considering the effects of mining and it is a common practice to consider the health and welfares of employees separated from the general well-being of the community. Environmental effects of mining can include erosion, loss of biodiversity and contamination of soil. These effects can take different forms such as noise and vibrations and in this context, an article highlighted the issue of noise and its impacts, both real and perceived, on the local community. Land degradation is the principal environmental problem caused by mining activities on land. Land degradation which can be defined as the process of progressive deterioration of biological (flora and fauna) and physical (soil, water, micro-climate, etc.) resources of the land, leading to declining productivity and unsustainable yields [3].

The impacts of mining activities on land do not only alter the terrestrial habitat of species but also renders formerly good land useless, The impact of mining on land was discussed and focused on blasting operations and its relation to quarrying and its potential for causing damage to nearby buildings, the effects of mining on land can occur in the form of soil erosion (i.e. erosion of access roads) which occurs when rainfall erodes the topsoil of the access roads as well as other parts of the mines. These effects can also occur as contamination of land due to wind-blown dust, fragmentation of land which occurs when large areas of land are broken up into smaller and smaller patches, making dispersal by native species from one patch to another difficult or impossible, and cutting off migratory routes. Isolation may lead to the local decline of species, or

genetic effects such as inbreeding and species that require large patches of forest simply disappear and this usually occurs as a result of vibrations, land degradation and soil quality alteration [4].

The impacts of mining activities on air are significant and can occur as particulate matter transported by the wind as a result of excavations, drilling, and blasting operations, transportation of materials, haul roads, exhaust emissions from mobile sources (e.g. cars, trucks, heavy equipment, etc. ) which raise these particulate levels. It can also occur in form of gaseous emissions from the combustion of fuels in stationary and mobile sources, blasting fumes from explosions and mineral processing (i.e. dust and particulates generated during crushing, grinding and screening). Once pollutants enter the atmosphere; they undergo physical and chemical changes before reaching a receptor, According to an Article by the U.S Protection Agency. These pollutants can cause serious effects to people's health and to the environment and as already known, the impacts of these activities are difficult to predict and calculate but should be considered since they could be a significant source of hazardous air pollutants [5].

The harmful impact upon the environment and the detrimental effect of such an impact is one of the most vital tasks of modern mining. The effects of mining activities on the environment cannot be overemphasized due to its long lasting and adverse effects both on the workers in the mines as well as its surroundings, these effects range from the destruction of flora and fauna, air pollution due to emissions from heavy-duty equipment, blasting fumes, dust, land degradation and decrease in soil nutrient quality. The scale of human activities has become such that most of the ecosystems of the earth have been disturbed in some way [6].

Mining can contaminate soils over a large area. Agricultural activities near a mining project may be particularly affected. According to a study commissioned by the European Union, Mining operations routinely modify the surrounding landscape by exposing previously undisturbed earthen materials. Erosion of exposed soils, extracted mineral ores, tailings, and fine material in waste rock piles can result in substantial sediment loading to surface waters and drainage ways. In addition, spills and leaks of hazardous materials and the deposition of contaminated windblown dust can lead to soil contamination[7].

Soil is a vital natural resource, which plays as a critical controlling component during the early stage of ecosystem development. Soil quality is defined as "the capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality and promote plant and animal health. Several factors make soil quality very difficult to define because soils are inherently variable. The mining activities invariably associated with the removal of fertile top soil organic layer enriched with vegetation cover. Mining activities generate a variety of wastes whose presence in soils has adverse effects on plant growth, such as low water infiltration rates, rough surface poor aeration, and high level of heavy metals, low fertility, salinity and extremes of pH [8].

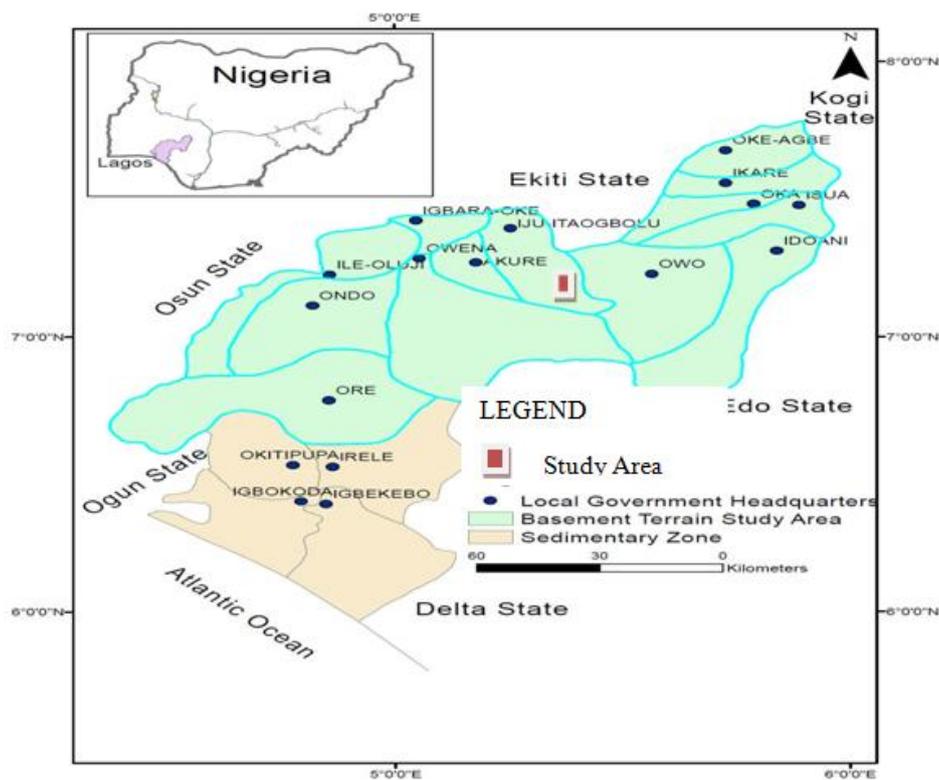
Similarly, in 2012 Ondo state government bound the activities of quarries in Ondo state as a result of incompliance with environmental laws of the state. This made the quarries in the state to go for environmental impacts assessments. But the environmental impact assessment carried out by the consultant of most of the companies' lack some required ingredients and the whole thing is as good as they have not done anything. This research work is therefore carried to evaluate the effects of Ebenezer quarry on Land and Air with water exclusive as there is no nearby stream or water body around the quarry area.

## **GEOLOGY OF THE STUDY AREA**

Ebenezer Quarry lies within latitude  $7^{\circ}20.261'N$  and  $7^{\circ}20.468'N$  and longitude  $005^{\circ}10.173'E$  and  $005^{\circ}10.357'E$ . It is situated at about 4km to Akure on Akure-Owo express road. Lithologically, this outcrop is made up of migmatite intruded by three petrological varieties of older granites. The migmatites consist of melanocratic paleosomes as well as felsic neosomes. The three petrographic varieties of older granite rocks recognized in this outcrop are;

- (i) Coarse-porphyritic biotite-hornblende granite;
- (ii) Medium to coarse-grained biotite-hornblende granite and;
- (iii) Medium to coarse-grained charnockite.

The study area as indicated by an oval-shaped indicator on the map shows that the area is majorly made up of medium to coarse-grained charnockite.



**Figure 1.1:** Geological Map of the Study Area (Adapted from ODSG [9])

### SAMPLE COLLECTION AND PREPARATION

Soil samples were collected at the surface 0 to 15 cm and sub-surface 15 to 30 cm within the quarry area from ten different locations using the grid system. In the grid system, the quarry area was divided into ten equal parts (grids) and in each grid system; five points were systematically sampled with calibrated stainless steel auger, composed and sub-sampled to constitute a representative sample. The samples were collected into appropriately labeled containers, preserved and stored. Samples were labeled SS<sub>1</sub>, SS<sub>2</sub>, SS<sub>3</sub>, SS<sub>4</sub>, SS<sub>5</sub>, SS<sub>6</sub>, SS<sub>7</sub>, SS<sub>8</sub>, SS<sub>9</sub> and SS<sub>10</sub> which constitute soil samples taken from the quarry area. After the collection of soil samples of locations. Collected samples were taken to the laboratory for soil analysis in order to determine the physicochemical parameters of the soils. The samples were air dried and then sieved via the use of a 2 mm sieve to reduce the size to 2 mm. The samples were later weighed and stored in a cool and dust free environment in order to allow the soil samples to be accurately analyzed using approved standard methods.

The methods adopted in this study are technical observations and field sampling of soils in the study area. All sample analysis was carried out in compliance with scientific methods including REA (Rapid Environmental Assessment) methods.

### DETERMINATION OF PHYSICOCHEMICAL PARAMETERS

#### Determination of Soil pH

Soil pH is a measure of the acidity or alkalinity of the soil, the pH of each soil sample was determined with a pH meter in accordance with ASTM D4972. 10 g of 2 mm sieved and air-dried soil sample was weighed into 100 ml beaker. 20 ml of distilled water was added to it. The suspension was stirred several times over a 30-minute interval with a glass rod. The pH of the soil in the beaker was measured. The pH measurement involved inserting the probe of the pH meter into a 1:1 ratio suspension of the sample in distilled water.

#### Determination of Exchangeable Cations (Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup>, K<sup>+</sup>)

Exchangeable Cations e.g., K, Na, and Mg in the soil samples were determined as described. 5 g of air-dried soil which had been passed through a 2 mm sieve was transferred into a centrifugal tube. To this was added 3 ml of NH<sub>4</sub>O AC and shaken on a mechanical shaker for two hours, then passed through a centrifuge rotating at 2000 revolutions per minute. The clear supernatant was decanted into a 100 ml volumetric flask and another 30ml NH<sub>4</sub>O AC solution was added to the residue, shook for 30 minutes and centrifuged. The supernatant was transferred into the same volumetric flask and steps were repeated again before the flask was

made up to mark with  $\text{NH}_4\text{O AC}$  solution,  $\text{Ca}^{2+}$ ,  $\text{K}^+$  was determined from the supernatant with the aid of flame photometer, while magnesium ( $\text{Mg}^{2+}$ ) was determined by the atomic spectrophotometer.

### Particle Size Analysis

The Buoyoucos hydrometer method was used for the soil particle size analysis. 50 g of 2 mm oven dried soil was weighed into a 250 mm beaker. 100 ml of Calgon was added and allowed to soak for 30 minutes and later transferred to dispersing cup. The suspension was then mixed for about 3 minutes with a mechanical stirrer. The soil suspension was later transferred quantitatively to a sedimentation cylinder and filled to the mark with distilled water while the hydrometer was in suspension. The plunger was inserted and moved up and down to mix the content thoroughly. The sediment was dislodged with strong upward strokes of the plunger near the bottom and by spinning the plunger while the disk is just above the sediment. The stirring was finished by two or three strokes. The time of the completion of the stirring was recorded. A drop of the amyl alcohol was added when the surface of the suspension was covered with foam. The hydrometer was lowered carefully into the suspension and the reading was taken after 40 seconds (i.e. R40secs). The hydrometer was removed from the suspension and the temperature of the suspension was recorded using a thermometer. The suspension was then mixed again and the 40 seconds reading was reported until it was sure that the reading obtained was accurate. Two hours after the final mixing of the suspension was carried out, another hydrometer reading was taken (i.e. R2hrs).

The calculation of the percentages of sand, silt, and clay was done by using Equations (1) to (3).

$$\% \text{ Silt} + \% \text{ Clay} = \frac{(R_{40\text{secs}} - R_a) + R_c}{W_t} \times 100 \quad (1)$$

$$\% \text{ clay} = \frac{(R_{2\text{hrs}} - R_b)}{W_t} \times 100 \quad (2)$$

where

Ra is 40 secs blank hydrometer reading

Rb is 2 hrs blank hydrometer reading

Rc is 40 secs correction factor (temperature  $\times 0.360$ )

Rd is 2hrs correction factor (temperature  $\times 0.360$ ) and

$W_t$  is Weight of Soil

$$\%(\text{sand} + \text{silt} + \text{clay}) = 100 \quad (3)$$

### Determination of Total Organic Matter

The Walkey and Black [10] procedure to measures decomposable organic matter in the soil was adopted. In this analysis, soil samples were ground into a fine powder and 1 g of the sample was weighed in duplicate and transferred to the 250 ml conical flask. 10 ml  $\text{K}_2\text{Cr}_2\text{O}_7$  was later added. 20 ml of concentrated  $\text{H}_2\text{SO}_4$  was added rapidly and the soil immediately swirled the flask gently until the soil and the reagent was mixed, and then swirled vigorously for one minute. The flask was later rotated again and allowed to stand on a sheet of asbestos for 30 minutes. After standing for 30 minutes, 100 ml of distilled water was added. 3 to 4 drops of ferroin indicator was added and titrated with 0.5 M Iron (II) ammonium sulphate. At this point, the ferrous sulphate was added drop by drop until the colour changed rapidly from green to brownish red. A blank titration was made but without soil. The reaction was  $\text{K}_2\text{Cr}_2\text{O}_7$  oxidizing carbon and the excess  $\text{K}_2\text{Cr}_2\text{O}_7$  is titrated with the Iron (II) Solution.

The percentage of the matter of the carbon in the organic matter can be gotten using Equation 4.

$$\% \text{ SoilOrganicCarbon} = \frac{(\text{Me. K}_2\text{Cr}_2\text{O}_7 - \text{Me. FeSO}_4) \times 0.003 \times 100 \times F}{W_t} \quad (4)$$

where

Me.  $\text{K}_2\text{Cr}_2\text{O}_7$  is titer value

Me is the Milli-equivalent (used for normality)

Me.  $\text{FeSO}_4$  is the titer value of sodium solution

F is the Correction factor, and

$W_t$  is the Weight of air-dried sample

Normality  $\text{FeSO}_4$  is 0.003

$\% \text{ Total Organic Matter} = \% \text{ soil organic carbon} \times 1.729$

where 1.729 is constant.

### Determination of Nitrogen Content of the Soil

Total Nitrogen was determined by macro Kjeldahl method. The soil sample was ground to pass through 0.5 mm sieve and 0.5 g weighed out into a dry 500 ml macro Kjeldahl flask, 20 ml of distilled water was added and then swirled for a few minutes before allowed to stand for 30 minutes. One tablet of mercury catalyst and 10 g of  $\text{K}_2\text{SO}_4$  was added to it followed by 30 ml of conc.  $\text{H}_2\text{SO}_4$ , the heat was applied at a low temperature to the

digestion stand until the water was removed and nothing ceased. The heat was then increased until digest cleared after which the mixture was boiled for 5 hours.

The digest was cooled and 100 ml of distilled water was added to it and then transferred into a bigger macro Kjeldahl flask with the sand particles retained in the original digestion flask. The sand residue was then washed with 500 ml of distilled water 4 times and aliquot transferred to the 750 ml flask on each occasion.

50 ml of  $H_3BO_3$  indicator solution was measured into 500 ml Erlenmeyer flask and placed under the condenser of the distillation apparatus. The 750 ml was Kjeldahl flask was then attached to the distillation apparatus and 150 ml of NaOH poured through the distillation flask by opening the funnel stopcocks. Distillation was then commenced and 150 ml of distillate collected. The ammonium nitrogen in the distillate was determined by titrating with 0.01N standard HCL with the endpoint being indicated by the colour change from green to pink.

Calculation:



Nitrogen converted to ammonia and reacted with  $H_2SO_4$  to form  $(NH_4)_2SO_4$



$$\%N = \frac{\text{Mass of N}}{W_t} \times 100 \quad (5)$$

$$\%N = \frac{M \times T \times 0.014 \times V_1}{V_2 \times W_t} \times 100 \quad (6)$$

### Determination of Total Phosphorus in Soil

The process involves taking 2 g of finely ground soil into 25 ml conical flask. 30 ml of  $HClO_4$  was added. It was digested on a hot plate in a fume cupboard at  $130^\circ C$  until the solution appeared clear. The temperature was increased when necessary. When digestion was completed, white fumes of  $HClO_4$  appeared and soil residue became white. It was not heated to dryness to avoid an explosion.  $HClO_4$  was added when necessary. The flask was removed and cooled to room temperature. 50 ml of distilled water was added and filtered into a 100 ml standard flask and the volume was made up to the 100 ml mark and the concentration of Phosphorus was determined. The same procedure was followed on other samples.

### AIR QUALITY ANALYSIS

The coordinates of the actual locations were determined using GPS and then sampling was carried out. Sampling/measurement of the chemical constituents of atmospheric pollutants was carried out at (10 points) using air particle counter and a fuel gas analyzer.

At each station, SPM was measured with the aid of air particle counter. The SPM concentration was recorded and printed out by the equipment. The Fuel Gas Analyzer was used to determine the other air pollutants ( $NO_x$ ,  $SO_x$ ,  $H_2S$ , and  $C_xH_x$ ) gases. The equipment was calibrated, appropriately positioned and the atmospheric concentration of the various gases read-off was directly on the screen of the equipment and printed with ancillary equipment. Wind speed and direction were determined using an electrically powered digital anemometer.

### VIBRATION MEASUREMENT

The measurement of the intensity of vibrations was carried using mathematical model taking into consideration the maximum instantaneous charge, the distance from point of the blast and also a mathematical constant (K), the calculations were done using Equation (7).

$$v = K \times Q^a \times DS^b \quad (7)$$

Where K = 700, Q = Maximum Instantaneous Charge, a = 0.7 (constant), DS = distance, b = -1.5

## II. Results

The results of the physicochemical parameters of soil samples taken at various depths gotten from the laboratory analysis are presented in Tables 1 and 2. Tables 3 and 4 show the concentrations of exchangeable cations at 0-15 cm and 15-30 cm respectively. Tables 5 and 6 show the results of the particle size analyses soil taken at 0-15 cm and 15-30 cm respectively. Tables 7 and 8 present the results of the total nitrogen and phosphorus of the soil samples taken at 0-15 cm and 15-30 cm respectively. Table 9 shows the heavy metal concentration of the soil samples. Table 10 present the results of air quality analysis and noise measurement and Table 11 shows the result of the noise and ground vibration with at various distances from the quarry face.

**Table 1:** Soil pH, Total Organic Matter and Total Organic Carbon at 0-15 cm

PARAMETER	SS <sub>1</sub>	SS <sub>2</sub>	SS <sub>3</sub>	SS <sub>4</sub>	SS <sub>5</sub>	MEAN VALUE
pH	5.20	5.40	4.02	5.42	4.26	4.86
Total Organic Matter (%)	5.34	3.40	1.94	2.64	1.65	2.99
Total Organic Carbon (%)	3.01	1.98	1.05	1.47	1.02	1.70

**Table 2:** Soil pH, Total Organic Matter and Total Organic Carbon at 15-30 cm

PARAMETER	SS <sub>6</sub>	SS <sub>7</sub>	SS <sub>8</sub>	SS <sub>9</sub>	SS <sub>10</sub>	MEAN VALUE
pH	4.86	4.95	4.87	5.06	4.60	4.87
Total Organic Matter (%)	4.52	2.92	1.78	2.14	1.45	2.56
Total Organic Carbon (%)	2.48	1.68	0.85	1.42	0.84	1.45

**Table 3:** Concentrations of Exchangeable Cations at 0-15 cm

PARAMETER	SS <sub>1</sub>	SS <sub>2</sub>	SS <sub>3</sub>	SS <sub>4</sub>	SS <sub>5</sub>	MEAN VALUE
Na <sup>+</sup> (cmol/kg)	0.71	0.71	0.64	0.68	0.65	0.68
K <sup>+</sup> (cmol/kg)	1.56	1.67	1.59	1.34	1.36	1.50
Ca <sup>2+</sup> (cmol/kg)	4.20	2.80	4.60	2.80	2.40	3.36
Mg <sup>2+</sup> (cmol/kg)	1.80	1.90	2.50	1.70	0.80	1.74

**Table 4:** Concentrations of Exchangeable Cations at 15-30 cm

PARAMETER	SS <sub>6</sub>	SS <sub>7</sub>	SS <sub>8</sub>	SS <sub>9</sub>	SS <sub>10</sub>	MEAN VALUE
Na <sup>+</sup> (cmol/kg)	0.68	0.69	0.68	0.78	0.65	0.70
K <sup>+</sup> (cmol/kg)	1.53	1.52	1.69	1.46	1.46	1.53
Ca <sup>2+</sup> (cmol/kg)	3.40	2.40	4.20	2.60	2.30	2.98
Mg <sup>2+</sup> (cmol/kg)	1.40	1.60	2.30	1.20	1.20	1.54

**Table 5:** Particle Size Analysis at 0-15 cm

PARAMETER	SS <sub>1</sub>	SS <sub>2</sub>	SS <sub>3</sub>	SS <sub>4</sub>	SS <sub>5</sub>	MEAN VALUE
Sand (%)	45.10	51.40	50.40	49.50	45.90	48.46
Clay (%)	29.90	31.60	32.60	27.50	33.10	30.94
Silt (%)	25.00	47.00	17.00	23.00	21.00	26.60

**Table 6:** Particle Size Analysis at 15-30 cm

PARAMETER	SS <sub>6</sub>	SS <sub>7</sub>	SS <sub>8</sub>	SS <sub>9</sub>	SS <sub>10</sub>	MEAN VALUE
Sand (%)	31.40	48.60	50.20	47.80	48.50	45.30
Clay (%)	40.60	36.40	31.80	25.20	32.50	33.30
Silt (%)	28.00	15.00	18.00	27.00	19.00	21.40

**Table 7:** Total Nitrogen and Phosphorus at 0-15 cm

PARAMETER	SS <sub>1</sub>	SS <sub>2</sub>	SS <sub>3</sub>	SS <sub>4</sub>	SS <sub>5</sub>	MEAN VALUE
Total Nitrogen (%)	0.24	0.16	0.16	0.11	0.09	0.15
Total Phosphorus (mg/kg)	5.52	5.68	8.98	9.48	7.12	7.36

**Table 8: Total Nitrogen and Phosphorus at 15-30 cm**

PARAMETER	SS <sub>6</sub>	SS <sub>7</sub>	SS <sub>8</sub>	SS <sub>9</sub>	SS <sub>10</sub>	MEAN VALUE
Total Nitrogen (%)	0.18	0.17	0.08	0.12	0.07	0.12
Total Phosphorus (mg/kg)	4.18	6.23	10.05	8.24	6.62	7.06

**Table 9: Heavy Metal Concentration of the Samples**

SAMPLE	As	Cd	Cr	Cu	Fe	Ni	Pb	Zn
SS <sub>1</sub> (0-15cm)	0.01	<0.01	1.22	1.82	198.26	1.76	0.76	56.86
SS <sub>6</sub> (15-30cm)	0.02	<0.01	1.36	2.12	267.28	2.35	0.78	47.88
SS <sub>2</sub> (0-15cm)	0.01	<0.01	1.14	1.98	248.50	3.45	0.82	49.62
SS <sub>7</sub> (15-30cm)	<0.01	<0.01	0.88	1.88	358.75	2.66	1.02	54.60
SS <sub>3</sub> (0-15cm)	0.02	<0.01	2.15	2.68	298.20	1.82	0.43	61.82
SS <sub>8</sub> (15-30cm)	0.02	<0.01	1.33	3.12	296.78	2.14	0.52	47.55
SS <sub>4</sub> (0-15cm)	<0.01	<0.01	1.76	3.20	181.62	1.46	<0.01	73.10
SS <sub>9</sub> (15-30cm)	0.01	<0.01	1.35	2.79	215.43	1.98	<0.01	67.85
SS <sub>5</sub> (0-15cm)	0.02	<0.01	2.20	1.23	347.60	0.85	0.22	47.86
SS <sub>10</sub> (15-30cm)	0.02	<0.01	1.68	0.94	297.82	1.43	0.45	51.28

**Table 10: Result of Air Quality and Noise Measurement**

S/N	NOISE (dB)	SPM (µg/m <sup>3</sup> )	CO (ppm)	CO <sub>2</sub> (ppm)	SO <sub>2</sub> (ppm)	NO <sub>2</sub> (ppm)	H <sub>2</sub> S (ppm)	C <sub>x</sub> H <sub>x</sub> (ppm)	O <sub>2</sub> (%)
1	48.7	18.0	ND	ND	0.00	ND	0.00	ND	21.0
2	52.7	71.0	ND	ND	0.00	ND	0.01	ND	21.2
3	46.4	30.0	ND	ND	0.00	ND	0.00	ND	20.8
4	65.2	20.0	ND	ND	0.00	ND	0.00	ND	20.6
5	40.7	10.0	ND	ND	0.00	ND	0.00	ND	20.8
6	45.3	25.0	ND	ND	0.00	ND	0.00	ND	21.0
7	40.5	20.0	ND	ND	0.01	ND	0.00	ND	20.6
8	55.4	30.0	ND	ND	0.00	ND	0.00	ND	20.8
9	44.3	40.0	ND	ND	0.00	ND	0.01	ND	21.0
10	41.8	15.0	ND	ND	0.00	ND	0.01	ND	20.8

NOTE: ND means "Not Determined"

**Table 11: Noise and Ground Vibration with Distance from the Quarry Face**

Distance from the face (m)	Maximum Instantaneous Charge	Noise (kPa)	Vibration (mm/s)
100	5802	0.41	322.58
200	5802	0.18	106.61
300	5802	0.11	55.74
400	5802	0.08	35.19
500	5802	0.06	24.63
600	5802	0.05	18.40
700	5802	0.04	14.38
800	5802	---	11.61
900	5802	---	9.62
1000	5802	---	8.12
1100	5802	---	6.98
1200	5802	---	6.07

### III. Discussion

From the results of the soil analysis obtained which are as shown from Tables 1 to 8 which when compared with the WHO standard. The average pH of soil samples collected from 0 to 15 cm is 4.8 and 15 to 30 cm is 4.87 which are below the maximum permissible limits of the World Health Organization which ranges between 6.5 and 9.5. The low pH value indicates a strongly acidic soil which shows intensive leaching, low exchangeable basic cations content as well as low microbial activity. The generally low pH values indicate that the soil within Ebenezer Quarry area is less electronegative, the pH values of the control sample taken 500 meters away from the quarry was 5.51 at the surface and 5.37 at the sub-surface level and these indicate that the on-going mining activities have led to a reduced pH level have already illustrated above. When the low pH levels are as a result of several mining operations on-going at the study area such as drilling and blasting operations, crushing and loading which produces dust in large quantities which then settles on the soil within the quarry hereby leading to its contamination and there were clear indications that fine material in waste rock piles resulted in substantial and gradual overlay of the topsoil with these contaminants. Average Levels of extractable nutrients such as nitrogen were 0.15 and 0.12 % at the surface and sub-surface levels, these low compositions of nitrogen in the soil are due to loss of organic carbon which contains nitrogen and nitrogen-fixing micro-organisms in soil but due to soil contamination resulting from various mining activities in the study area such as dust and fumes settlement generated during blasting operations etc.

The levels of phosphorus at the 0-15 cm and 15-30 cm are 7.36 and 7.06 mg/kg and this slightly exceeds the Food and Agricultural Organization (FAO) maximum permissible limit which is 7.0 mg/kg. Considering the ability of phosphorus to enhance soil productivity, these phosphorus levels observed are due to the inadequate organic matter in the soil. Good soils possess nitrogen and phosphorus in large quantities as they are soil macronutrients; hence the results obtained from the study areas show excessive soil contamination.

The respective total organic matter (TOM), which includes remains of plants, animals, and micro-organisms in various stages of decomposition for the 0-15 cm and 15-30 cm are 2.99 and 2.56% respectively as shown Table 1 and 2. Total Organic Matter (TOM) sustains the life of the soil, and it gives the soil some properties such as absorption and retention of water and nutrient accumulation which are essential for soil structure stability and adequate aeration but TOM is dependent on the quality of organic matter present as well as the percentage of organic carbon in the soil which is the chief element of TOM. When Total Organic Carbon present in TOM is less than 12% by weight of the soil samples, it implies that the soil material is derived from mineral sources such as rocks, while concentrations above 12% suggest that the soil material has been derived from decayed organic sources. But from the results obtained, the Total Organic Matter present in the soil samples is less than 12% by weight of the soil samples, indicating that the soil material is derived from mineral sources like rocks and points to the effects rock quarrying activities have on the study area and soils with predominant rocky sediments are widely known to be nutrient-deficient.

Varying concentrations of the heavy metals (Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Nickel and Zinc) measured in the soil samples were recorded, but their distribution levels across the sampling points including the control were fairly consistent. The levels of arsenic in the soil samples were below instrument detection limit and was about 0.2 mg/kg in both 0-15 cm and 15-30 cm soils and this happens to be the World Health Organization (WHO) and the Food and Agricultural Organization (FAO) maximum permissible limit; cadmium was below instrument detection limit for all soil categories and is below the World Health Organization's maximum permissible limit of 0.2 mg/kg; while chromium ranged between 1.14 – 2.41 mg/kg in surface soil and 0.88 – 2.64 mg/kg in sub-surface soil, Copper (Cu) recorded relatively low concentrations between the range of 1.23 – 4.30 mg/kg and 0.94 – 2.79 mg/kg for surface and sub-surface soils respectively and this is well below the World Health Organization's (WHO) maximum permissible limit which is 40 mg/kg. Iron (Fe) showed the highest concentration between 181.62 and 347.60 mg/kg for surface soils and between 215.43 and 358.75 mg/kg for sub-surface soils. The concentration of iron which is highest further indicates that there is heavy metal contamination in the study area due to the negative impacts of on-going rock quarrying activities. Nickel (Ni) concentrations in the soil samples were 0.68 – 3.50 mg/kg and 1.18 – 3.08 mg/kg for surface and sub-surface soils respectively while respective values for lead (Pb) were <0.01 – 1.02 mg/kg. Zinc (Zn) recorded the second highest metal concentration in the soil samples varying from 36.65 mg/kg to 73.10 mg/kg in surface soil and 41.57 to 67.85 mg/kg in sub-surface soils and this exceeds the World Health Organization's (WHO) maximum permissible limit which is 60 mg/kg and this further buttresses the fact that there is increasing heavy metal contamination in the study area. Heavy metals in soils originate from several sources and are present in several forms. The chemical species, complexes, absorbed and solid forms in which different metals occur in soils have profound effects on their bioavailability, toxicity to soil fauna as well as mobility and to the underground water table. Most of the metals in stable forms in soils are derived from natural processes such as weathering, erosion and surface run-off and even depositions by precipitation. However, increasing metal concentration is mainly caused by industrial inputs in the forms of various rock quarrying

activities such as particulate discharge from the plants and changes in the land use due to the construction of mineral handling and preparation plants which happens to be the case in the study area.

From the results of the air quality analysis as shown between Tables 10 and 11, it indicated that suspended particulates in the air ranged between 10 and 71  $\mu\text{g}/\text{m}^3$  and this result obtained indicates that Suspended Particulate Matter (SPM) are present in high levels in the study area and these high levels of SPM are caused by drilling, blasting, loading, vehicular movement, crushing operations as well as mineral handling, mineral preparation and associated activities which mainly contributes SPM to the atmosphere. Recent studies confirm that high concentrations of SPM are known to irritate the mucous membranes and may initiate a variety of respiratory diseases. Dust coat on leaves are also known to reduce the rate of photosynthesis and thereby reduce plant growth; they are also known to cause metal corrosion (at relative humidity above 75%), eroding building surfaces and discoloring/destroying painted surfaces.

The Average Noise level obtained in the study area was 45.1 decibels (dB) and this was within the FMENV (Federal Ministry of Environment) daily average limit which is 90 dB for 8hrs exposure hereby indicating that the noise level was minimal as opposed to the intensity of vibration whose average above a distance of 1000 m was about 6.53mm/s and this exceeds the permissible level of vibration recommended by the Federal Ministry of Environment which is 5.00mm/s for distances over 1000 m. This high level of vibrational intensity is due to the excessive charging of blast holes with explosives and as already known, shocks and vibrations as a result of blasting in connection with mining can lead to noise, dust, and collapse of structures in surrounding inhabited areas although these effects are yet to be noticed in the study area but will become noticeable with time due to the fact that these activities are ongoing.

#### IV. Conclusion

The effects of quarrying on the environment from the study area have shown an increase in the soil pH value, the total organic content and the total organic matter. The heavy metal concentration in the soil has increased. The pH of the soil is 4.8 which indicate that the soil is acidic. The levels of phosphorus in the soil have slightly exceeded the Food and Agricultural Organization (FAO) standard. Good soils possess nitrogen and phosphorus in large quantities as they are soil macronutrients; hence the results obtained from the study areas show excessive soil contamination. The average concentration of iron in the soil is 181.62 mg/kg which further indicates that there is heavy metal contamination in the study area due to the negative impacts of on-going rock quarrying activities. There is a high concentration of Suspended Particulate Matter (SPM) in the air which has a negative effect on the people of the environment. The vibration level is above the standard and has great impacts on the structures within the environment.

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